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Silicon Dioxide Insulator Semiconductor Gases

Gate Oxide Field Oxide

Term (Index)

Silicon dioxide, SiO₂

Definition

silica; native oxide of silicon and at the same time an excellent insulator, the most common insulator in semiconductor device technology, particularly in silicon MOS/CMOS where it is used as a gate oxide; high quality films are obtained by thermal oxidation of silicon; thermal SiO₂ forms smooth, low-defect interface with Si; can be also readily deposited by CVD; SiO₂ performs various functions in silicon device technology which to large degree depends on outstanding characteristics of, also used in non-Si devices; Key parameters: energy gap Eg ~ 8eV, dielectric strength 5-15 x 10⁶ V/cm depending on thickness, dielectric constant k = 3.9, density 2.3 g/cm³, refractive index n = 1.46, melting point ~ 1700 °C; prone to contamination with alkali ions and sensitive to high energy radiation; in semiconductor technology used in the form amorphous thin films; single crystal SiO₂ is known as quartz.

Notes

<http://semiconductorglossary.com/default.asp?searchItem=silicon+dioxide%20+SiO2>

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Response to Office Action of October 27, 2006 (Response D)

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3. Oxidation

3.1 Introduction

The phenomenal success of silicon as the starting material for the fabrication of integrated circuits lies in the fact that SiO₂ layers can be produced by thermal oxidation of silicon substrates and by deposition from the gas or liquid phase. The oxide films are useful in several ways:

- 1. They provide isolation between devices.
- 2. They mask against impurities, dopant diffusion, and environmental effects.
- 3. They provide stability against mechanical damages, e.g., scratching.
- 4. They act as an insulating layer between conductors.
- 5. They act as the gate dielectric.

Basically, the SiO₂ layers can be used in the ways described above successfully. In using such layers as gate dielectric, and for isolation purposes, the demands for control of the dielectric properties are the most severe. Dielectric properties determine transistor thresholds and parasitic leakage currents. For other applications, the requirements are less stringent.

In this chapter, thermal oxidation of a semiconductor surface is considered. Thermal oxidation of silicon in dry oxygen and in water-vapor-containing medium have been the preferred techniques. This is because oxide films produced in this way have the best properties. This chapter deals with the oxidation of silicon. In the last section of the chapter, the oxidation of compound semiconductors, such as GaAs, GaP, and InP, is discussed. For semiconductors other than silicon, the oxidations that produce acceptable oxide films have not been possible. This fact has resulted in less than the expected usefulness of such semiconductors.

3.2 Oxide Properties

Table 3.1 summarizes the most important properties of silicon dioxide. Thermally grown SiO₂ films are amorphous. They consist of a random three-dimensional network of silicon atom tetrahedrally surrounded by four oxygen atoms each [1]. The tetrahedra are joined by oxygen bridges at the corners, as shown in the two-dimensional network depicted in fig. 3.1. As is apparent,